Control of Weld Residual Stresses and Distortion In Thin Section Panel Fabrication

Status: Transitioned

PROBLEM / OBJECTIVE

The increased use of thin steels in Arleigh Burke (DDG-51) class AEGIS destroyers, LPD-17 landing platform docks and other Navy ships has aggravated the problem of distortion caused by welding. Shipyards typically achieve the required fairness by flame straightening the stiffened panels near the end of the fabrication process. The overall goal of this project was to develop methods of predicting and controlling welding distortion rather than removing accumulated distortions by flame straightening.

ACCOMPLISHMENTS / PAYOFF

Process Improvement:

This project developed a number of techniques that are effective in reducing weld distortion during the fabrication of Navy ships. This includes development of finite element analysis tools to predict distortion as well as practical welding procedures to control distortion. The techniques that were developed include the following:

- control of initial plate flatness
- modification of welding practices to control buckling distortion
- transient thermal tensioning to control buckling
- welding practices to control angular distortion
- design practices to control buckling distortion

Implementation and Technology Transfer:

Technology developed by the NJC has been utilized in a wide range of applications:

- Shipyards have applied this technology to DDG-51, LHD-1, and LPD-17 class ships.
  The thermal tensioning technique was successfully used for production of panels at Northrop Grumman Ship Systems, Pascagoula and New Orleans.
- Distortion analysis and control tools helped the Marine Corps Expeditionary Fighting Vehicle program reduce costs for tooling, in-process fabrication, and rework.
- The NJC has extended the technology to commercial applications. One company reduced its scrap rate, due to distortion, from 60 percent to zero with a corresponding significant reduction in manufacturing costs.

Expected Benefits:

These mitigation techniques helped the Navy achieve a 20-40% reduction in distortion related costs where the technology has been applied. For example, control of weld distortion resulted in cost avoidance of over $1 million on each DDG-51 destroyer. These savings result from reduction in fitting time, rewelding time, rework, and flame straightening. Cost savings over a 5 year period are estimated to exceed $21 million, yielding a return on investment (ROI) of more than 10:1.

TIME LINE / MILESTONE

Start Date: September 1993
End Date: August 2000

FUNDING

ManTech Investment: $1.3M

PARTICIPANTS

- Naval Surface Warfare Center - Carderock
- The Ohio State University
- Edison Welding Institute
- Northrop Grumman Newport News
- Babcock & Wilcox
- Bath Iron Works
- MIT
- Northrop Grumman Ship Systems, Pascagoula
- Northrop Grumman Ship Systems, New Orleans
- University of Illinois